

Study on the Application of Energy Performance Contracting in Housing Field Based on Consumption Demand

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Abstract-The energy consumption of buildings from construction to operation accounts for nearly 45% of the total energy consumption, so the energy saving and emission reduction in building field has a long way to go. Taking consumption demand as the starting point combined with current energy consumption and management situation of housing in our country, this article explores ways to realize energy saving and emission reduction effectively by energy performance contracting in housing field, trying to establish an energy performance contracting system with the purpose to promote the concept of green consumption and the implementation of green building.

Keywords-housing consumption, consumer psychology, energy performance contracting

I. INTRODUCTION

In recent years, with China's social and economic development and continuous rising of living standards, both the absolute value and the proportion of energy consumption of the housing in total social energy consumption have kept increasing, which brings the issues of energy saving and emission reduction increasingly prominent.

On May 21, 2008, the Ministry of Housing and Urban-Rural Development of the People's Republic of China(MOHURD for short) put forward "proposals on the promotion of heat metering and energy saving reconstruction of the existing housing in northern heating areas"; on June 10, 2008, MOHURD issued the notice on "heating metering management method of civil buildings"; on March 17, 2010, when premier Wen Jiabao chaired the executive meeting of the state council, he pointed out that the energy performance contracting should be actively promoted. It means that energy performance contracting should be signed by energy-using organizations such as enterprises and public institutions with professional energy-saving service companies to provide new service mechanism for energy-saving design, reform and operation management and promote the use of new energy-saving technologies and products by market

methods to improve energy efficiency and realise energy-saving and emission reduction.

In China, the implementation of energy performance contracting in housing field is still a new subject. The authors of this article believe that energy consumption of the housing is closely related to the users' lifestyle and their energy consumption psychology. Therefore, understanding the consumer demand is particularly important to how to implement the energy performance contracting in the housing field.

II. OVERVIEW OF ENERGY PERFORMANCE CONTRACTING

Energy Performance Contracting (EPC for short), is a totally new market-operation-based energy-saving mechanism developed in western developed countries in the 1970s. What the energy performance contracting promotes is not a product or technology, but a financial management approach that can reduce energy costs.

A. Concepts and Operating Modes of Energy Performance Contracting

Energy performance contracting is kind of business operation pattern through which services company engaged in energy-saving (known as Energy Service Company abroad, ESCO for short, and called Energy Management Company in China, EMC for short) signs energy-saving service contracts with customers who are willing to make energy-saving reconstruction to provide a set of services including energy-saving potential analysis, project feasibility study, designing, financing, equipment purchasing, construction, energy-saving testing, personnel training, etc. The energy service company makes the investment and takes the risk of the energy-saving reconstruction of the project to ensure the realization of the

energy-saving quantity and benefits promised in the contract. It will get its investment back and make profit from realized energy-saving benefits. In fact, energy performance contracting is a kind of operation mode that energy-saving project investment is paid with expected energy costs which will be saved.^[1] The management mechanism of EMC is an energy-saving investment service management in which EMC Corporation share the energy-saving results with customers after customers seeing energy-saving benefits with a win-win situation achieved.

In foreign countries, there are three main operating modes of energy performance contracting: energy-saving benefits sharing-based type, energy-saving quantity guaranteed type, energy costs trusteeship type. In the first model, the energy service company provides funds to make feasibility analysis of energy-saving project with customers and purchase energy-saving equipment. It makes profits from the energy benefits saved in the project. After the project is finished, equipments and facilities are owned by the customers. In the second model, the energy service company and its customers finance the purchase of equipment jointly and the energy service company ensures the energy-saving quantity. If the energy-saving goal is not achieved, it will compensate the customers. In the third model, energy service companies will entrust all energy costs of customers and equipments needed for the reconstruction of the project should be provided by the energy company. The energy service company enjoys the energy-saving benefits alone.

B. The Development of Energy Performance Contracting in China

The concept of energy performance contracting was introduced into the country in the 1990s. In 1996, with the support of "Chinese Energy-saving Promotion Project" implemented by our government in cooperation with the World Bank, three demonstration EMCos are established respectively in Beijing, Liaoning and Shandong, opening the prologue of introducing and promoting energy performance contracting in our country. From 1997 to June 2006, the energy efficiency investments of the three demonstration EMCos have steadily increased. They have cumulatively implemented 453 energy-saving projects for

their clients with total investment of 1.262 billion yuan. EMCos have got 420 million yuan net income through the implementation of these projects, while the customers' net income is 8 to 10 times that of EMCos. These projects have good energy-saving and environmental benefits: reaching an energy-saving capacity of 1.37 million tons of standard coal per year^[2]. The great success that these three exemplary energy service company have achieved led to the development of domestic energy-saving service industry. In June 2000, Resources Division of the former State Economic and Trade Commission issued "notice on further promoting energy performance contracting mechanism" which pointed out that as a new market-oriented energy-saving mechanism, energy performance contracting will effectively improve the energy using efficiency, greatly reduce energy consumption and ease China's energy demand stress.

At present, China's EMCo industry organization - China Energy Conservation Service Industry Committee of China Energy Conservation Association (EMCA for short) has more than 300 members. The main energy performance contracting model they use is energy-saving benefits sharing-based type with most business areas lying in industrial and construction field. Energy-saving of buildings involves lighting, ventilation, heating and cooling of commercial and residential buildings.

III. HOUSING CONSUMPTION PSYCHOLOGIES OF CONSUMERS

The energy consumption of the housing, the users of which are the general public, mainly lies in the use and maintenance aspects. So ways and reasons of energy consumption can be understood and better energy measures can be developed only after the residents' housing consumption demands are understood. For such a special commodity as house, residents primarily have following consumption psychologies.

A. Realistic Psychology

The main purpose of most consumers buying house is for their own use. Therefore, their consumption psychology has such realistic characteristics as followed. Firstly, requiring economy. With the traditional concept that house

is an important part of home, the vast majority of consumers are very concerned about the prices and using cost of the house; secondly, focus on safety. Consumers have high requirements for the quality of the building itself, the quality of building materials and decoration materials; thirdly, the pursuit of comfort. As a private space, consumers are increasingly concerned about the comfort of their living environment requiring reasonable housing structure and layout, good effect of lighting, heating and ventilation.

B. Showing off Psychology

In the Chinese concept, "face" is an important issue. Emphasis put on "face" is reflected in all aspects of life as well as in housing consumption. First of all, there are comparing behaviours in housing consumption. Consumers compare the size of their houses, the luxury degree of the decoration, etc; secondly, to a certain extent, housing condition is a symbol of status. Consumers hope to show their identity and position through the differences of their houses very much; finally, for some affluent consumers, they are more willing to have a personalized and unique house to highlight their uniqueness.

C. "Pursuit of the Harmony of Man with Nature"

"The harmony of man with nature" means that man and the natural world integrate into a whole, pursuing the harmonious unity between man and nature. It is the highest pursuit of Chinese building since ancient times. Ancient Chinese architectural practice integrates many aspects of classical philosophy including yin and yang, gas, dao, five elements, eight diagrams and other theories, formatting the "feng shui" theory of the ancient buildings. Its essence is to guide people to use the natural environment reasonably and coexist with nature harmoniously.

D. Investing Psychology

With China's deep reform, opening up and the continuous improvement of people's living standards, more and more people purchase houses no longer to meet their housing needs, but as an investment. So when these consumers buy the house as an investment, what they focus on naturally falls on the appreciation ability of the houses. Therefore, whether the design of the house is

forward-looking, and whether the quality of materials used and house can withstand the test of time have become the focus of consumer concern.

IV. THE ENERGY USEAGE AND MANAGEMENT SITUATION OF THE HOUSING

Energy management in China started late, especially in housing field. At present, there are some problems in housing energy use and management such as high energy consumption, low energy efficiency, poor management and so on.

A. High Energy Consumption

Consumers' seeking the comfort of the housing and their over comparing behaviours lead to the developers' blind pursuit of big house, which directly causes excessive consumption of building materials and the land resources. The popularity of household appliances leads to a significant increase in non-renewable resources consumption such as oil, coal and freshwater. Data in table one shows the increase of energy consumption with the development of economy. It is confirmed by authoritative organization that the energy consumption in construction industry (including energy consumption in the construction, use and demolition of the building) is up to more than 45% of the total social energy consumption. According to the data: 80% or more of annual new buildings and 95% of the existing buildings (nearly 400 million square meters) are high energy consumption ones. China's unit energy consumption of buildings is 3-5 times that of developed countries. With little architectural science and technology used, the energy-saving technology is relatively backwards and energy consumption is growing increasingly serious. All these have attracted attentions of all parties.^[2]

B. Low Energy Efficiency

The energy efficiency of existing housing and household appliances is very low, resulting in significant energy waste. For example, little consideration is given to insulation and heat dissipation capacity of the original building when the structure was designed and building materials were selected. Therefore the insulation and heat dissipation capacity is so poor that the room appears cold in winter and hot in summer, causing the user to consume

much energy for getting warm or cool to live more comfortable. Another example is washing machine. The loss of freshwater resources is caused by the product design, but China is a water-scarce country.

TABLE I

CHINA'S ENERGY CONSUMPTION AND PER CAPITA ENERGY CONSUMPTION

Years	Energy consumption (1000 tons of standard coal)	Life energy consumption (1000 tons of standard coal)	Per capita life energy consumption (kg standard coal)
2003	174 9900	19 8270	153. 9
2004	203 2270	21 2810	164. 2
2005	224 6820	23 4500	179. 9
2006	246 2700	25 3880	194. 7
2007	265 5830	26 7900	203. 3

Source: China Statistical Yearbook 2008, China Statistics Press, .2008

C. Energy Management Lack of Coordination

At this stage, energy management in housing is in a state that lack of coordination: the real estate developer responsible for the construction process, the property management company responsible for the maintaining process, the users responsible for their own use.

V. THE IMPLEMENTATION OF THE HOUSING ENERGY PERFORMANCE CONTRACTING FROM THE CONSUMER NEEDS

Housing energy consumption runs through housing construction, using and demolition. These three phases are closely related as a whole. Therefore, only a set of energy management system is established can the energy consumption be effectively reduced and low-carbon and emission reduction be realized. Commodity production is to meet consumer needs and housing is no exception. Housing energy management system should adopt energy performance contracting system cooperating with energy services companies on the base of taking full account of consumer demand (shown in Figure 1).

A. Energy Service Company Cooperating with Real Estate Developer

During housing construction stage, the energy service

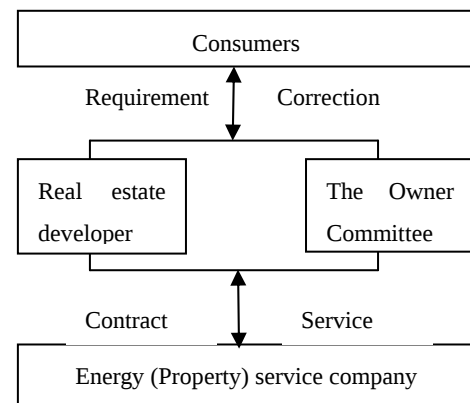


Figure 1 Housing energy performance contracting system

company signs an energy management contract with the real estate developer. They cooperate through energy-saving benefits sharing-based mode. So in this stage, they can correct and guide consumers' unreasonable and excessive demand by controlling the house area and other means to advocate the green consumption concept. Consumers' reasonable requirements such as for comfort, economy and security can be met by constructing "green building".

Green building is defined as the building which can save resources (save energy, save land, save water and save materials) to a maximum extent during the entire life cycle (including site selection, planning, design, construction, use and consumption, management and operation and demolition), protect the environment and reduce pollution, provide safe, healthy, applicable and efficient service space for people, and coexist with nature in harmony. This means that buildings have been considered as an integral part of the natural ecosystem. The core concept of "Green building" is to minimize energy and resource consumption, reduce the impact and damage to the environment, use new technology, new materials which will help improve the living quality as far as possible, use recyclable materials in the existing science, technology and management level. The elements evaluating it include the green degree of following aspects: water-saving, heating, cooling, greenhouse gases, pollution, artificial lighting, indoor ventilation and quality of sunshine.

"Green building" can not only satisfy consumer demand for large house space and meet environmental protect and safety requirements, but also be done with the lowest total cost during the entire life cycle, achieving the rational use of energy. "Green building" also focuses on harmony with the environment and emphasizes the cultural and geographical connotations of the building, meeting the consumer's needs for respect for nature and the pursuit of personalization. The ultimate goal of "Green building" is to promote the sustainable development of buildings.

B. Energy Service Company Cooperating with the Owners' Committee

The energy service company can perform some functions of the property company to take the energy management responsibility of the housing during its using phase, ensuring low energy consumption and low-carbon emissions to realize energy performance contracting during the entire life cycle. However, the realization of energy performance contracting during its using phase needs the cooperation of the Owners' Committee and the energy service company.

Energy consumption in heating, the uses of household appliances and other aspects of life can be managed through energy costs trusteeship mode. In this mode, Consumer representatives --- the Owners' Committee can sign an energy use and management contract with the energy service company according to the actual needs of consumers to achieve the purpose of reducing both energy consumption and cost of consumers under the premise of guaranteeing the comfort of living. Furthermore, the housing built before 2007 can be reconstructed by adding external insulation wall with the energy consumption reduced by 36 percent. This will meet consumers' needs not only for comfort but also for economy by reducing the consumers' energy costs and housing maintenance costs.

VI. CONCLUSIONS

Energy saving, emission reduction and the advocate of green life are not only the general trend, but also the necessary means to achieve sustainable social development. As an effective energy-saving measure, energy performance contracting has been fully implemented in the building field.

This paper attempts to discuss energy management issues of the housing form the point of consumer demand and concludes that energy performance contracting should be actively promoted in housing field with the development of green building to realise green transformation of this field. We also try to establish an energy performance contracting system for housing with the hope of providing some help for the realization of energy saving and emission reduction.

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